Climate Change and Human Health Impacts of the Oil and Gas Sector

US Environmental Protection Agency

Office of Air Quality Planning and Standards

Overview

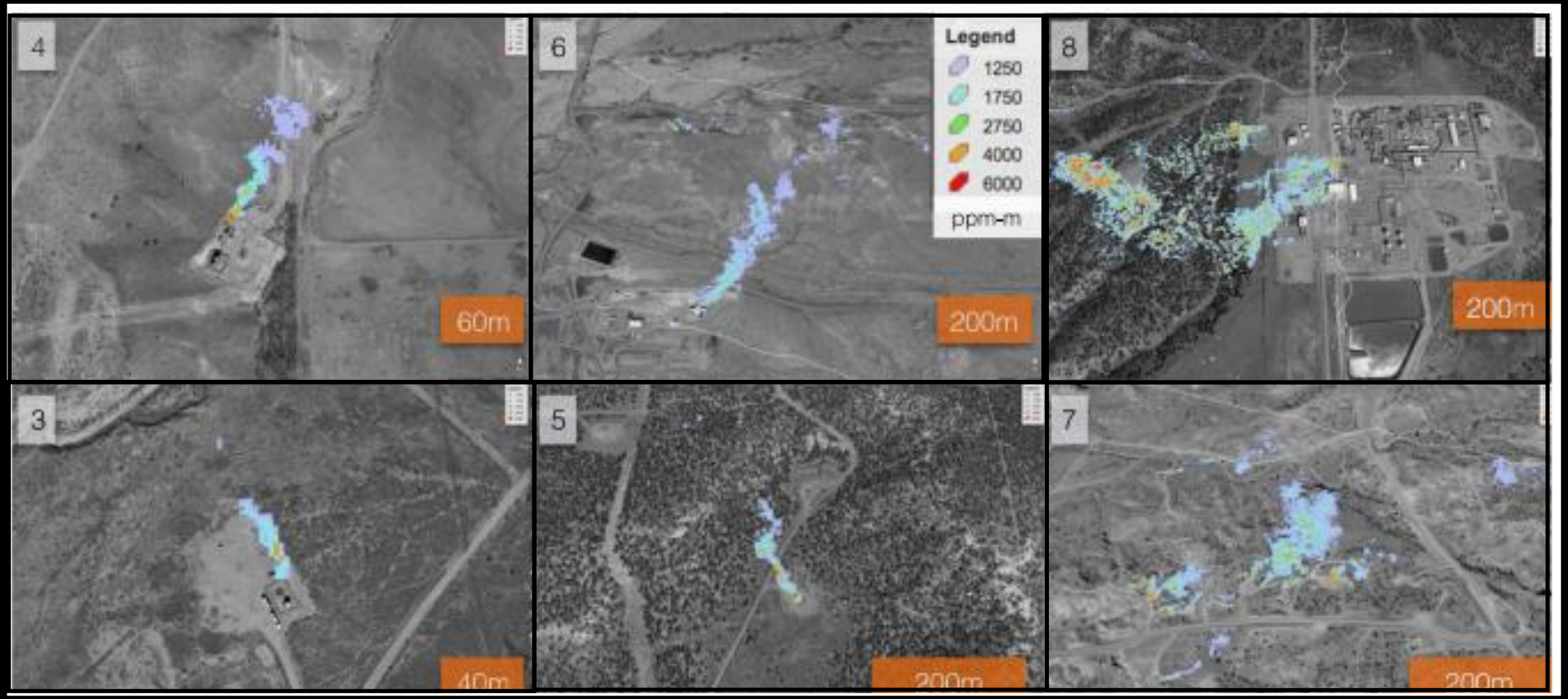
- Emissions: where, what, and when?
- Methane and climate change
- Global and regional air quality: ozone
- Local air quality: hazardous air pollutants

Emissions from oil and gas production

Where: Oil and Gas Wells in the Lower 48 States

Source: U.S. Energy Information Administration, 2021

What: many sources spread out over a large area



When: detecting methane plumes from aircraft fly-overs

Source: Frankenberg et al., 2016

Super-emitters

Relatively few sites account for most methane emissions.
Most super-emitting events are not by design.
Large emission events can be short-lived.

Basin	Top 10% account for this percentage of total emissions	Study
Marcellus	77%	Caulton et al., 2019
Marcellus	50%	Omara et al., 2016
California	60%	Duren et al., 2019
Barnett	80%	Zavala-Araiza et al., 2015

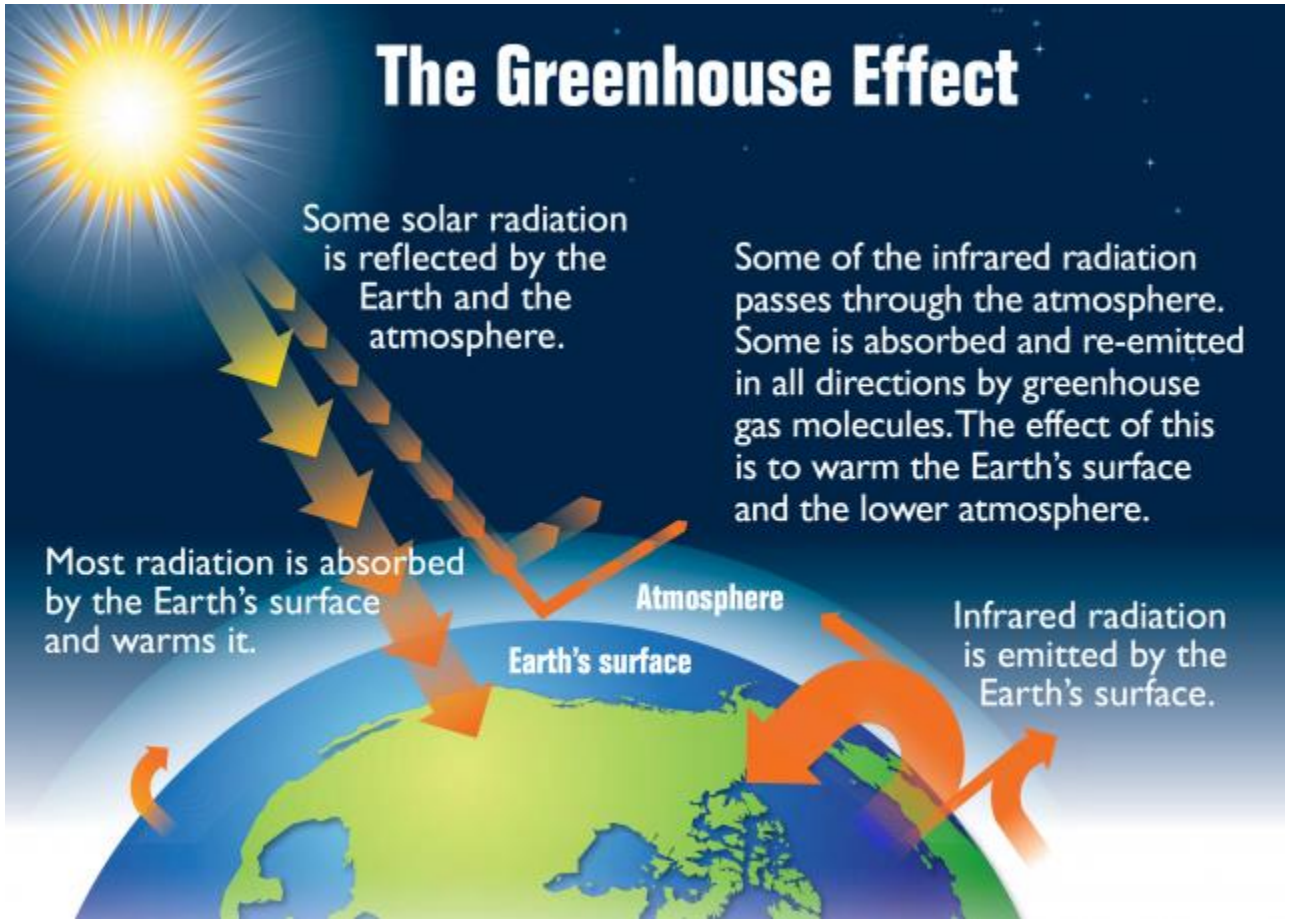
Camera recording methane emissions from a storage tank
Source: Lyon et al., 2016

What is emitted?

- Methane: greenhouse gas and contributor to global ozone
- Volatile organic compounds and NOx: contribute to local and regional ozone
- Particulate matter
- Hazardous air pollutants

Climate change and methane

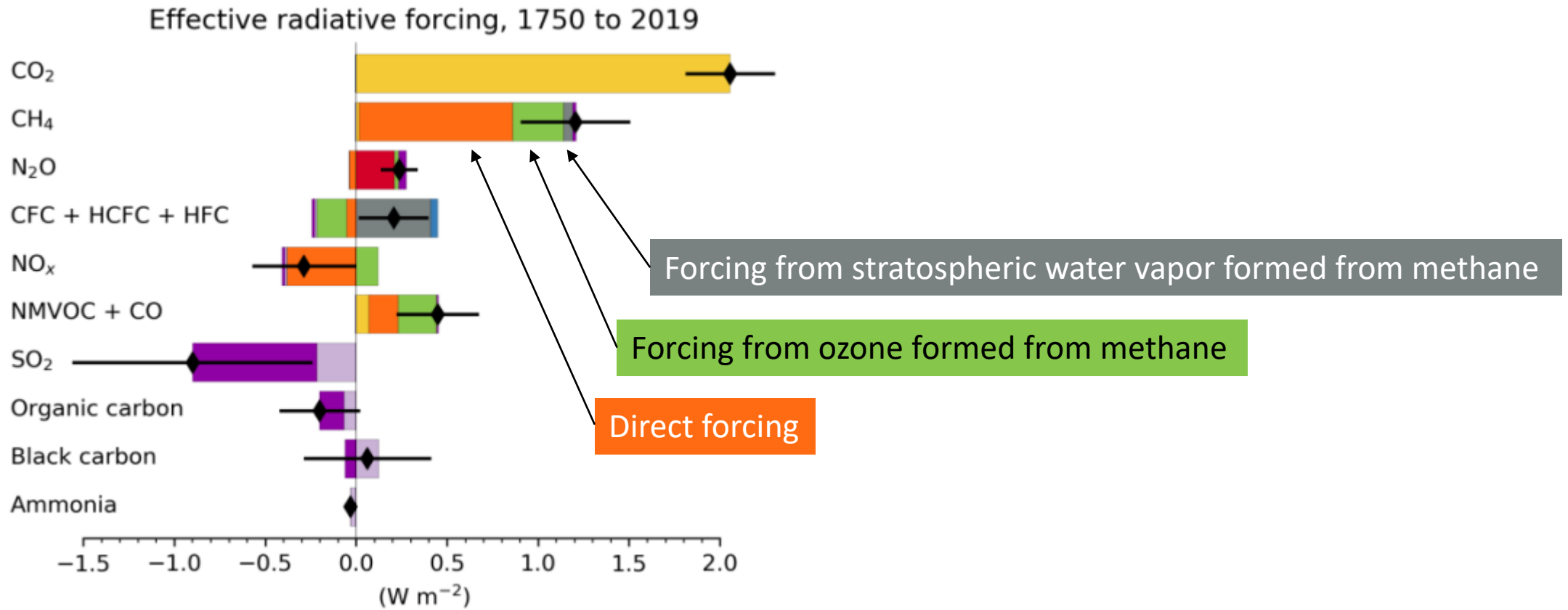
Methane and climate effects



- Methane is a greenhouse gas, about 200 times less abundant than CO_2
- Per unit of emissions, likely 28 times more powerful warming agent than CO_2 over 100-year timespan
- Forms ozone, also a greenhouse gas
- Produces water vapor in the stratosphere, also a greenhouse gas
- Eventually oxidized to form CO_2

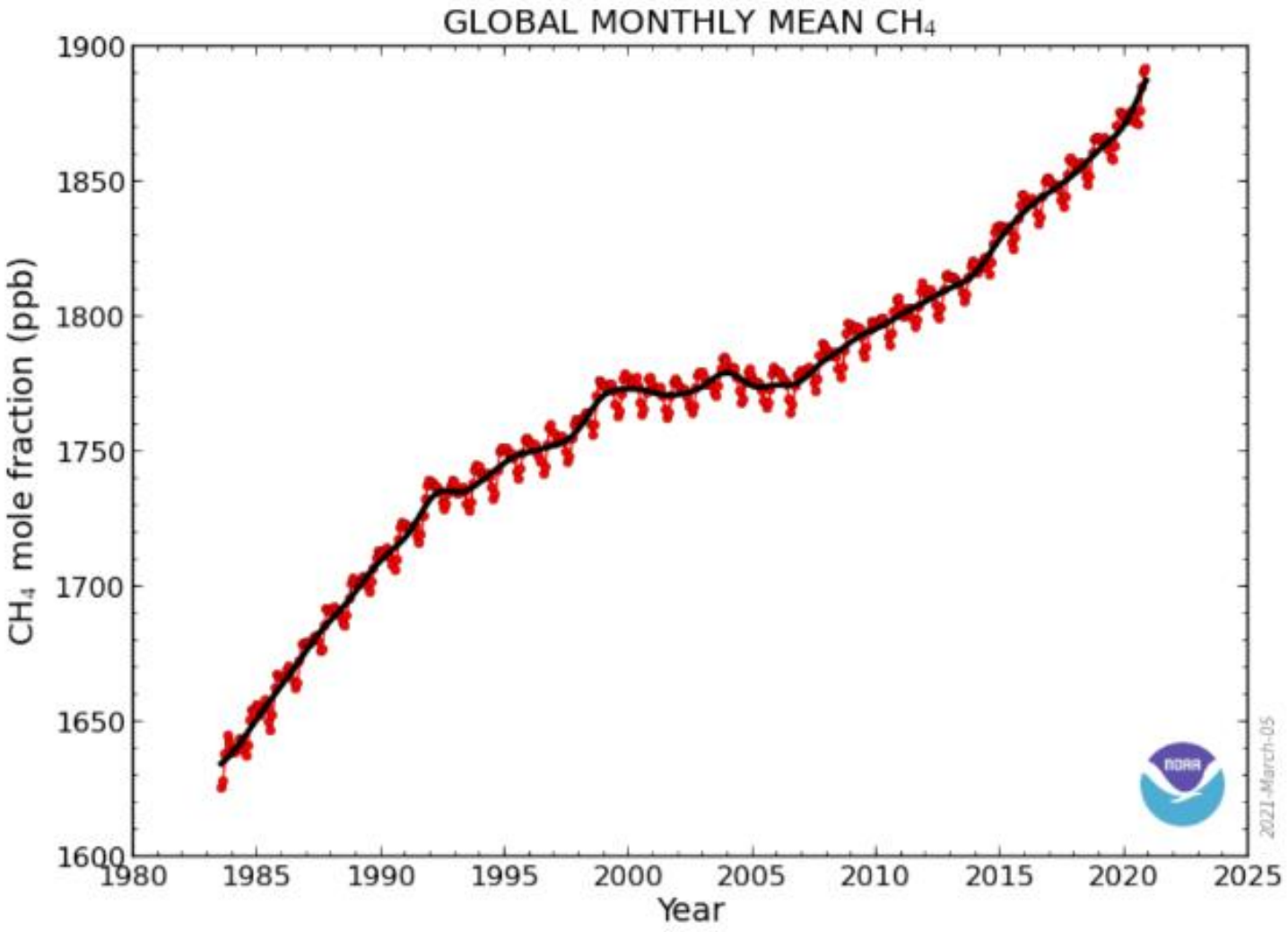
- Methane has a shorter lifetime in the atmosphere meaning that reducing emissions will have a more immediate benefit

Methane is historically the second largest source of warming after CO_2



Source: IPCC Sixth Assessment Report (2021), Chapter 6, Short-lived Climate Forcers

Methane has been increasing in recent years



Methane even increased in 2020 when many other indicators of fuel use and industrial production were lower due to the pandemic

Effects of climate change: coastal flooding

Coastal flooding: sea level rise can cause flooding even on sunny days

(Source: U.S. Climate Resilience Toolkit)

Effects of climate change: inland flooding

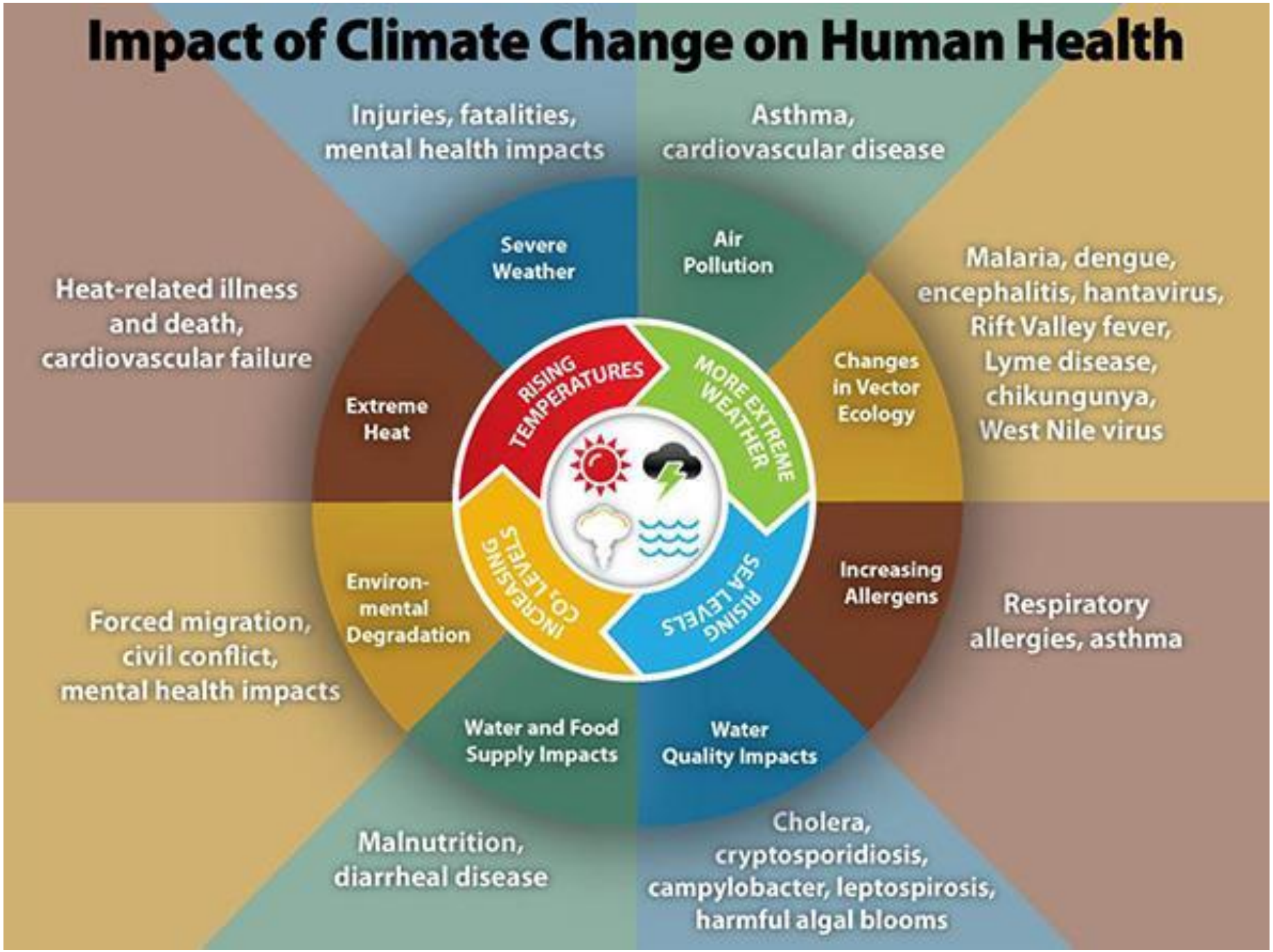
(Photo credit: Michael Stokes/Flickr/CC 2.0)

Effects of climate change: extreme heat

Energy poverty: lower income people are especially susceptible to extreme heat and may not be able to avoid the increased temperatures due to climate change.

High temperatures can strain the electric grid.

Extreme heat can require stopping outdoor work.



(Source: Centers for Disease Control)

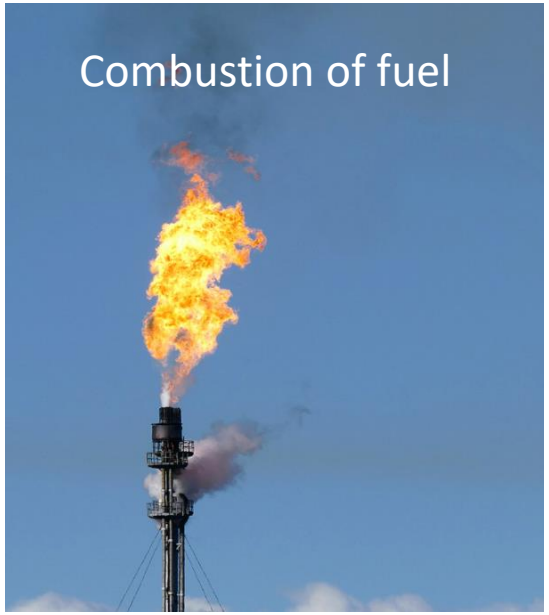
Vulnerability to climate change

- Climate change effects everyone, but not in the same way
- Lower income people are more likely to live in areas that are more vulnerable to climate change
  - Air Quality and Health: 15% more likely to currently live in areas with the highest projected increases in childhood asthma diagnoses
  - Extreme Temperature and Labor: 25% more likely to currently live in areas with the highest projected reductions in labor hours due to extreme temperatures
  - Coastal Flooding and Property: 16% more likely to currently live in areas where the highest percentage of land is projected to be lost to sea level rise
- More info: EPA report on Climate Change and Social Vulnerability in the United States
- Solutions: reduce greenhouse gases and increase resilience

Health effects from ozone pollution

Ozone is a powerful oxidant formed in the atmosphere from NO_x and organic compounds

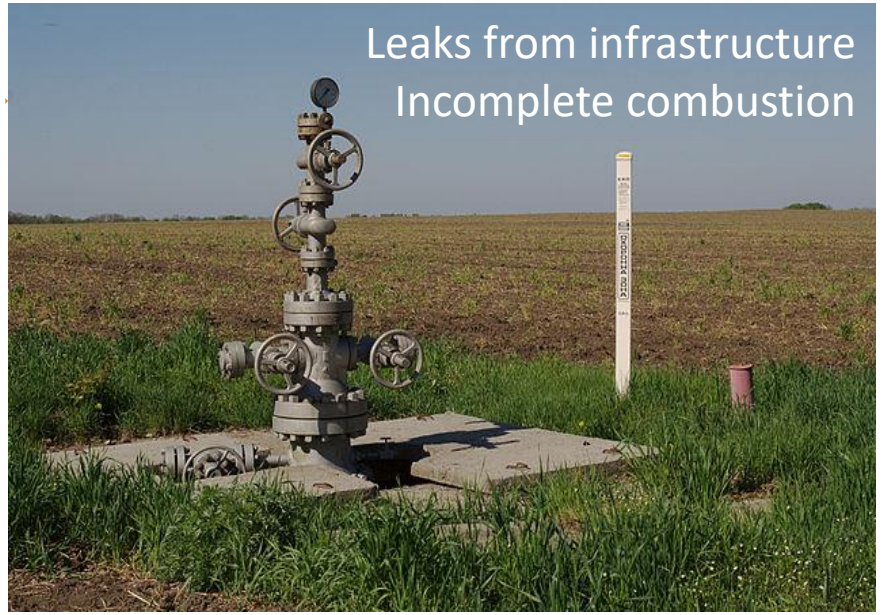
Oxides of Nitrogen (NO_x)



(Source: Wikimedia Commons)

Ozone

Volatile Organic Compounds and Methane



(Source: Wikimedia Commons)

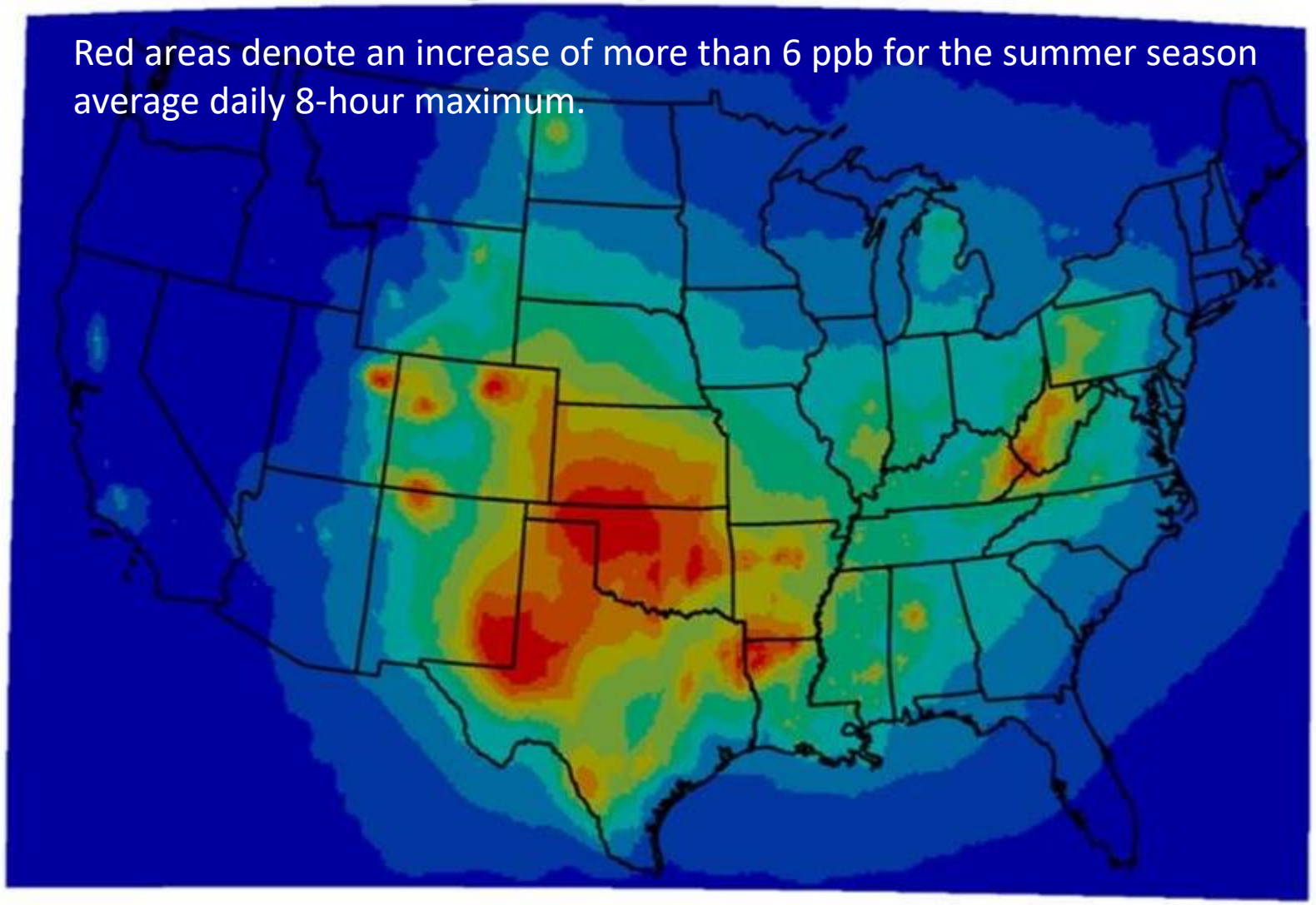
Health effects of ozone exposure

- When inhaled, ozone reacts chemically with many biological molecules in the respiratory tract, leading to adverse health effects
- Some of these effects include:
  - Cause coughing and sore or scratchy throat.
  - Make it more difficult to breathe deeply
  - Make the lungs more susceptible to infection.
  - Aggravate lung diseases such as asthma, emphysema, and bronchitis.
  - Increase the frequency of asthma attacks.
- Current ozone national ambient air quality standard:
  - 70 parts per billion (ppb)
  - Annual 4^{th}-highest daily maximum 8-hour concentration, averaged over 3 years

Ozone attributed to NO_x and VOC emissions from oil and gas production

Annual total health effects:

- 670–1300 ozone-related premature deaths
- 1,000 hospital admissions
- 3,600 emergency room visits
- 100,000 lost work days
- 1M cases of increased asthma symptoms

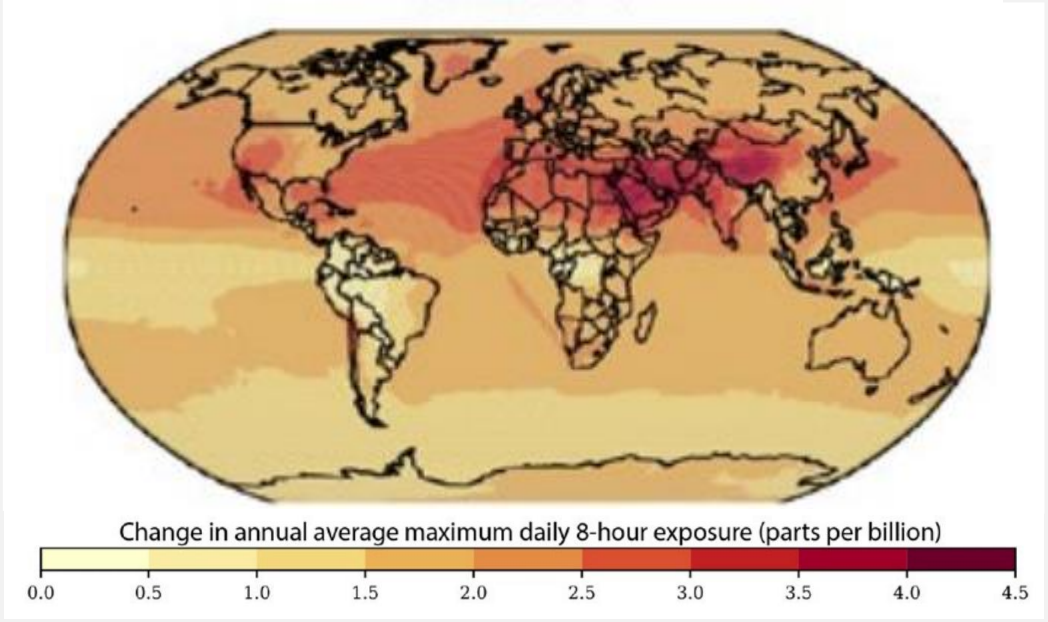


Source: Fann et al. 2018

Methane produces ozone: a global air quality problem

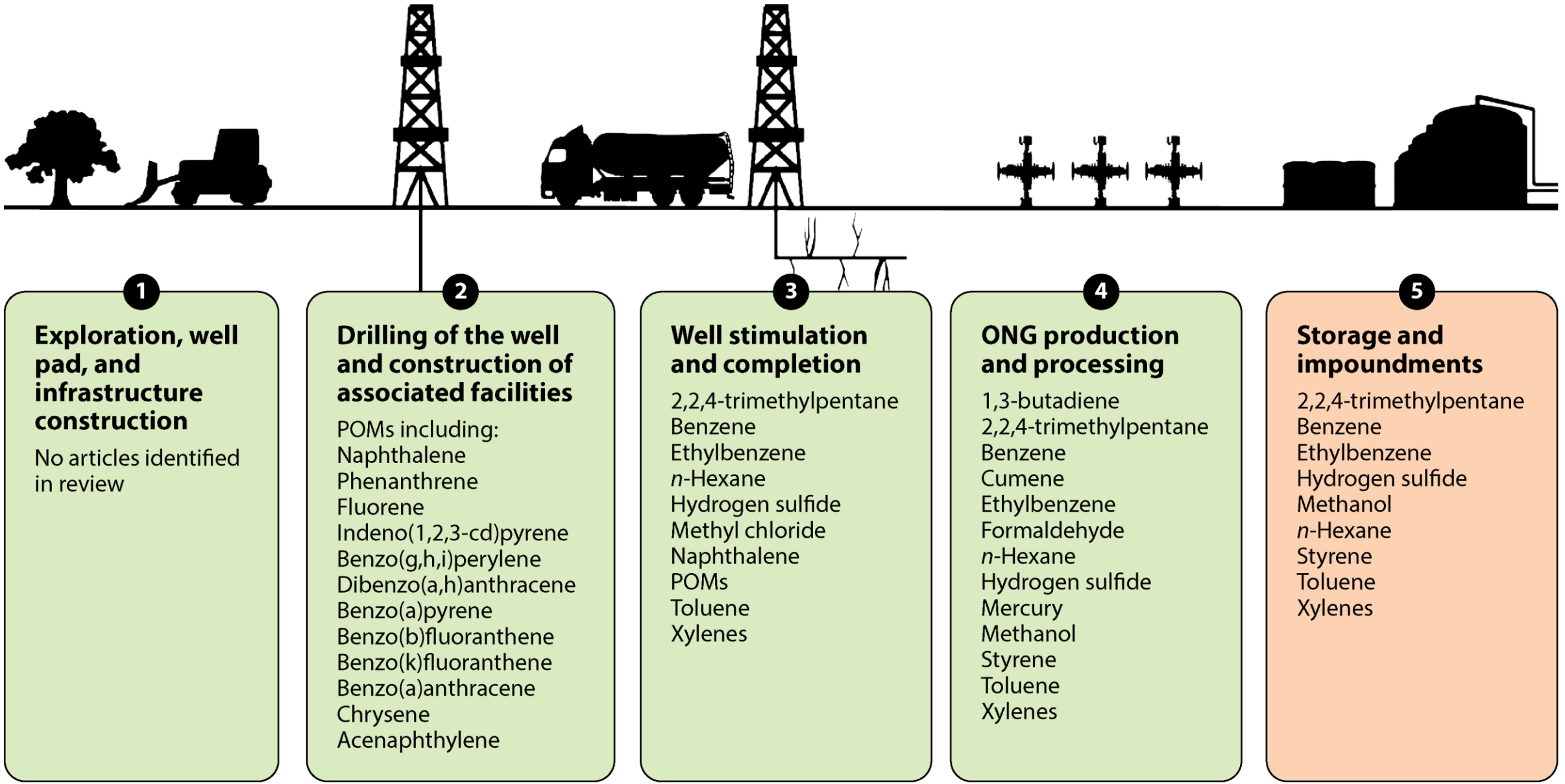
- Climate and Clean Air Coalition 2021 Global Methane Assessment
- A 50% reduction in methane concentrations would avoid 100,000 premature respiratory mortalities globally
- US Government is promoting the Global Methane Pledge: reduce methane emissions by 30% by 2030

Change in annual average, maximum daily 8-hour ozone exposure (parts per billion) due to decreasing anthropogenic methane concentration by half



Source: UNEP/CCAC Global Methane Assessment

Local health effects from Hazardous Air Pollutants



Review of the sources of hazardous air pollutants

Source: Garcia-Gonzales et al., 2019

Evidence of near-source health effects due to hazardous air pollutants

Historically, oil and gas production facilities have been located relatively far from where people live.

Rise of hydraulic fracturing and population growth have led to more people living near wells. Different states have different setback requirements.

BTEX, formaldehyde, and acetaldehyde compounds have been detected at higher levels near oil and gas production areas. These compounds are associated with increased human health risks.

Image source: Associated Press

Health risks examined in near-source studies

- Some studies have found increased health effects or reported symptoms among residents living closer to well pads compared with those further away. Risks that have been studied include
  - Cancer
  - Respiratory and cardiovascular health
  - Pregnancy and child-birth
  - Self-reported symptoms
  - Hospitalizations

- Data and study limitations have made it challenging to conclusively determine if oil and gas sources have contributed to these health effects

- Research gaps: intermittent emissions are more difficult to attribute to health effects.

Source: Health Effects Institute–Energy, Special Report, 2019

Summary

- Emissions from oil and gas production affect health on local, regional, and global scales
- Methane emissions from oil and gas production are an important contributor to climate change
- EPA is working to reduce emissions from this sector as part of our mission to protect human health and mitigate climate change